$$E_K = E_g + E_{lost}$$

$$\frac{1}{2}mv^2 = mgh + E_{lost}$$

$$\frac{1}{2}(45)(280)^2 = 45(9.8)h + 8.5\times10^5 J$$

$$P = \frac{W}{t} = \frac{\Delta E_{nergy}}{t}$$

$$P = \frac{\Delta E_g + \Delta E_K}{t}$$

$$P = \frac{mgh + \frac{1}{2}mv^2}{t}$$

Q 5 $\quad eff = \frac{W_{out}}{W_{in}} \times 100\%$

$$= \frac{mg\Delta h}{}$$

2.8×10^{5} J

=

$E_g + E_K = \text{Constant}$

$\downarrow \qquad \uparrow$

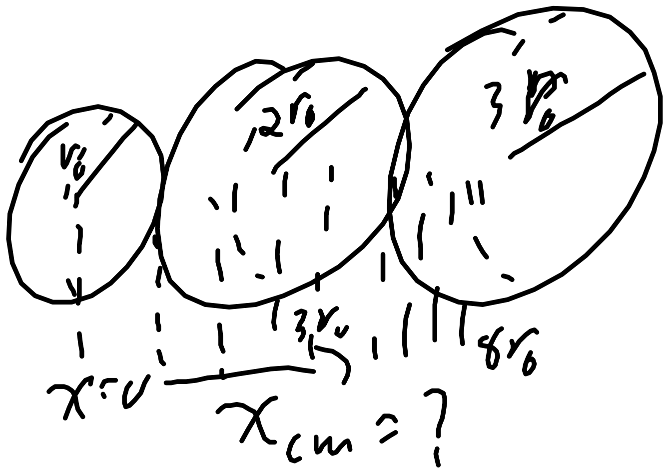
$-\frac{GMm}{r}$ closer $E_K\uparrow$

$m_A v_A = -m_B v_B$

$60\text{kg}\ v = 40$

$V_A = 2/3 \quad V_B = -2/3$

Block 2-4



$$M_{Total} x_{cm} = m_1 x_1 + m_2 x_2 + m_3 x_3$$

treat mass as being at the centre

$$V = \frac{4}{3}\pi r^3 \quad M = \rho V$$

density

$$M = \underbrace{\rho \frac{4}{3}\pi}_{K} r^3$$

$$M = Kr^3$$

$$M_{total} = Kr_0^3 + K(2r_0)^3 + K(3r_0)^3$$

'8

$$= 36 K r_0^3$$

$$36 \cancel{K r_0^3}\, x_{cm} = \cancel{K r_0^3}(0) + \cancel{K} 8 \cancel{r_0^3} \times 3(r_0)$$
$$+ \cancel{K}\, 27 \cancel{r_0^3} \times 8 r_0$$

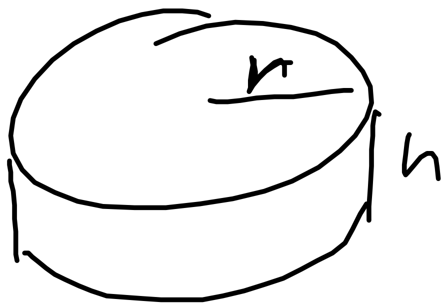
$$36 x_{cm} = 24 r_0 + \cancel{224}\,216\, r_0$$

$$x_{cm} = \frac{240 r_0}{36}$$

$$\boxed{x_{cm} = 6.7 r_0}$$

Q47 $M = K r^2$

$V = \pi r^2 h$



$M = \rho V$

$$M = (\rho \pi h) r^2$$

take out K

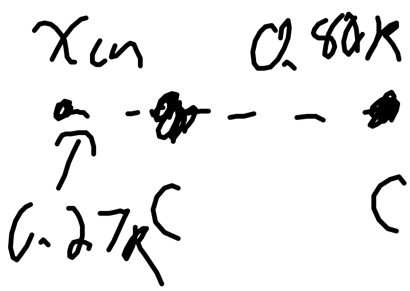
$$M_{total} = K(2R)^2 - KR^2$$

$$(K4R^2 - KR^2)x_{cm} = K(2R)^2 0 + -KR^2(0.80R)$$

$$x_{cm}(3\cancel{KR^2}) = 0 - \cancel{KR^2}(0.8R)$$

$$x_{cm} = \frac{-0.80R}{3}$$

$$x_{cm} = -0.27R$$

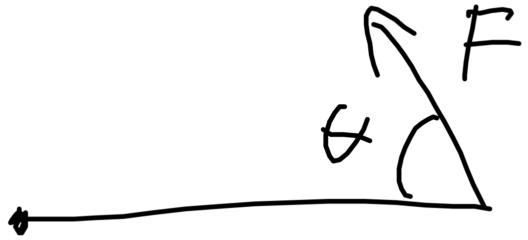


away from c'

Notes:

torque $\boxed{\tau = Fr\sin\theta}$

torque $\boxed{\tau = Fr\sin\theta}$



reference point
or rotation point

Statics

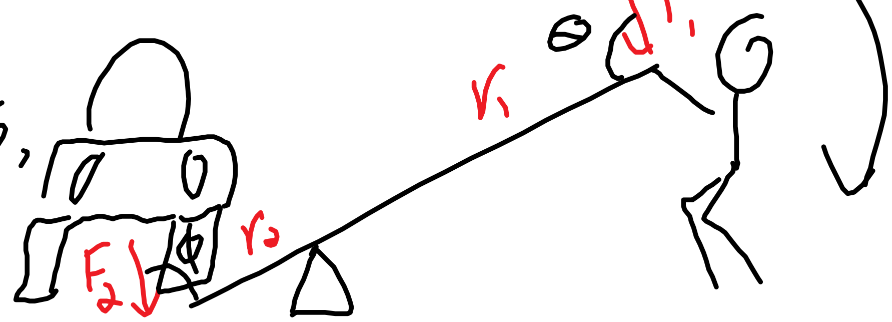
$$\sum \tau_c = \sum \tau_{cc}$$

clockwise

counterclockwise

$$\sum F = 0 \text{ or } F_{up} = F_{down} \quad F_{right} = F_{left}$$

e.g.,



fulcrum

if $r_1 = 90.0cm$ and $r_2 = 10.0cm$

$F_2 = 2000N$ $F_1 = ?$

$\tau_c = \tau_{cc}$

$F_1 r_1 \sin\theta = F_2 r_2 \sin\phi$

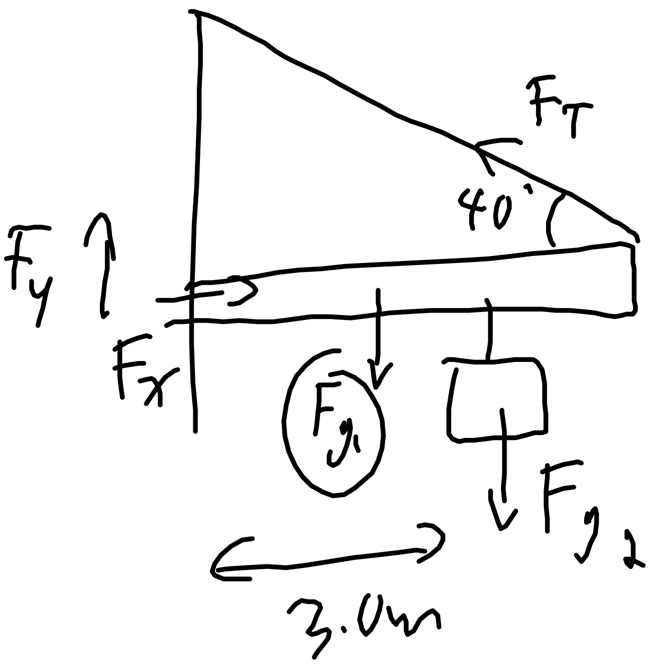
$F_1 \times 90cm \underline{\sin 90} = 2000N(10)\sin 90$

$F_1 = \frac{20000}{90} N$

$\boxed{F_1 = 220N}$

eg. A 5.0 kg 4.0m long beam is holding a 10.0 kg sign 3.0m down the length from a wall. A cable supports the beam from the end making a 40.0º angle to the beam.

1. what is the tension in the supporting cable?
2. what are the x and y components of the force of the wall on the beam?



mc x2 + SA /70

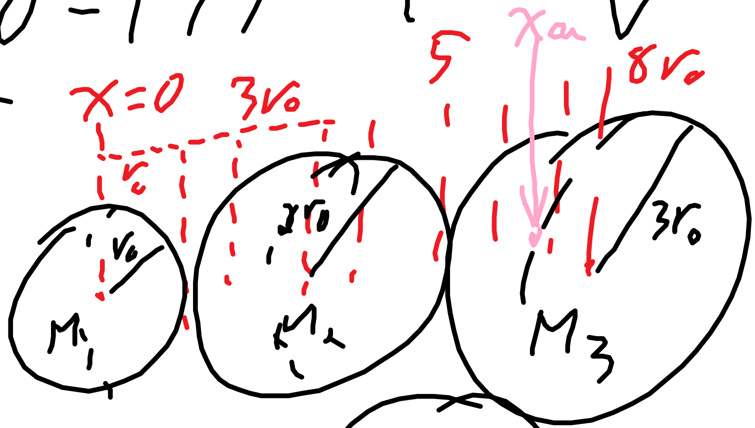
Block 2-3

HW

p170-171

Q45

$\rho = \frac{M}{V}$ density



$$M = \rho V = \rho \frac{4}{3}\pi r^3 = K r^3$$

$$M_1 = K r_0^3$$

$$M_2 = K(2r_0)^3 = 8Kr_0^3$$

$$M_3 = K(3r_0)^3 = 27Kr_0^3$$

$$M_{total}\, x_{cm} = M_1 x_1 + M_2 x_2 + M_3 x_3$$

$$(Kr_0^3 + 8Kr_0^3 + 27Kr_0^3)\, x_{cm} = 0 + 8Kr_0^3(3r_0) + 27Kr_0^3(8r_0)$$

$$x_{cm}(36\cancel{Kr_0^3}) = 24\cancel{Kr_0^3}(r_0) + 216\cancel{Kr_0^3}\, r_0$$

$$x_{cm} = \frac{240\, r_0}{36} = 6.7\, r_0$$

Q47 treat the cutout as negative mass
mass = density x volume
= density x π r^2 x h = kr^2

cutout

$$M_1 = K(2R)^2 \qquad M_2 = (-)KR^2$$

$$(M_1 + m_2)x_{cm} = m_1x_1 + m_2x_2$$

$$(K4R^2 \cancel{4} - KR^2)x_{cm} = 0 + -KR^2(0.8R)$$

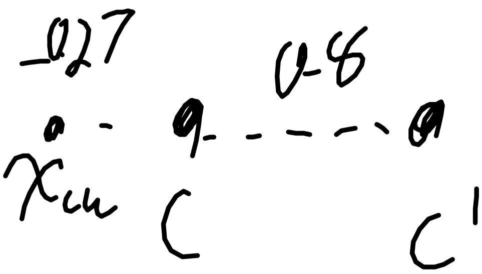
↑

(ignore for now

$$3K\cancel{R^2}\,x_{cm} = -\cancel{KR^2}\,0.8R$$

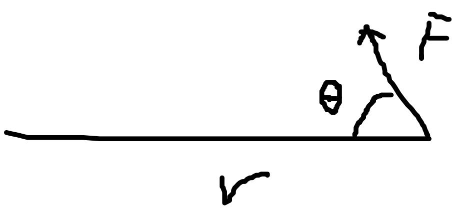
$$x_{cm} = \frac{-0.8}{3}R = -0.27R$$

?



recap

torque, $\tau = Fr\sin\theta$



Theory:

static

sum of torques = 0

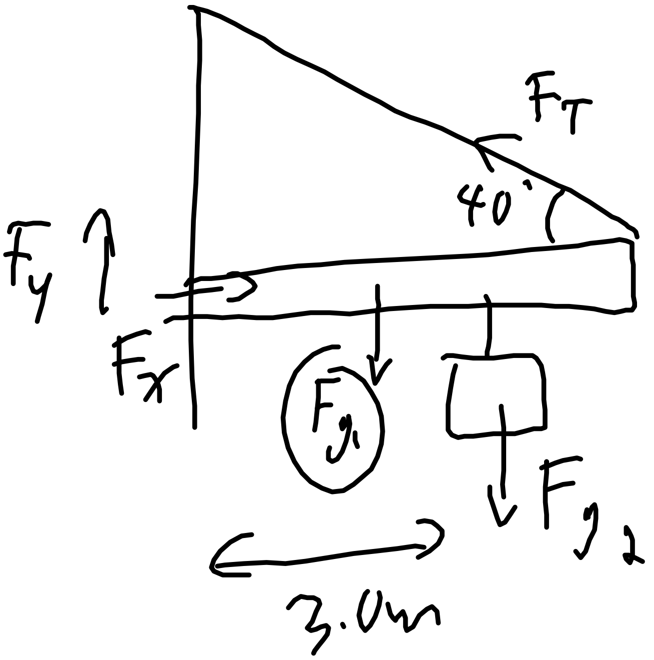
torques clockwise = torques counterclockwise

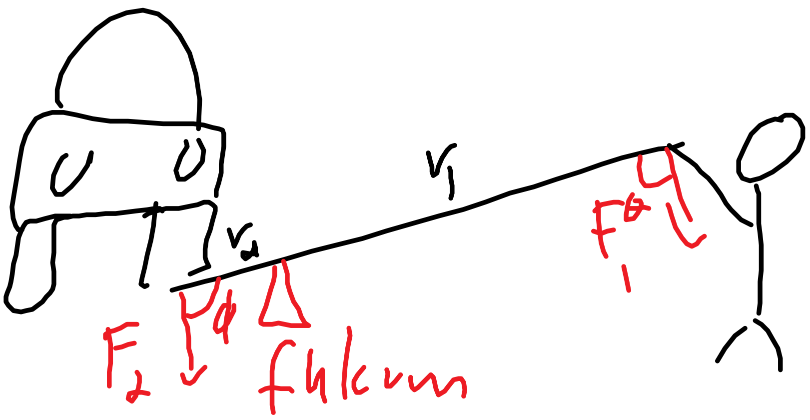
forces add to zero
forces up = forces down
forces right = forces left

eg. 1. You want to lift the tire of a car, requires 2000N of force (1/4 of the weight of a 800kg car). Use a jack with a handle length of 1.0m and a lifting part of 0.10 m. What force is required?

2 A 5.0 kg 4.0m long beam is holding a 10.0 kg sign 3.0m down the length from a wall. A cable supports the beam from the end making a 40.0º angle to the beam.

a) what is the tension in the supporting cable?
b) what are the x and y components of the force of the wall on the beam?





$\theta = \phi = 90$

$$\tau_c = \tau_{cc}$$

clockwise

counter clockwise

$$F_1 r_1 \sin\theta = F_2 r_2 \sin\phi$$

$$F_1 (1.00\text{m}) \sin 90 = 2000\text{N} (0.10\text{m}) \sin 90$$

$$\boxed{F_1 = 200\text{N}}$$

$p = 1.2 \times 40$
$= 48$

$-30 + 6v$

$78 = 6V$

$v = 13 m/s$

$$\Delta E_g = \Delta E_k$$

$$-GMm\left(\frac{1}{r_f} - \frac{1}{r_i}\right) = \cancel{\frac{1}{2} m v^2} \quad \underline{E_k}$$

$$-6.67\times10^{-11}(5.98\times10^{24})(450)\left(\frac{1}{6.38\times10^{6}} - \frac{1}{7\times10^{6}}\right)$$

Q5/6 $P_{in} = 1500 W$

$$P_{out} = \frac{W}{t} = \frac{mgh}{t}$$

$$= \frac{250(9.8)24}{52}$$

$$eff = \frac{P_{out}}{P_{in}} \times 100\%$$